**Concept Presentation: Enzyme Function And Metabolism**

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Curriculum Expectations: SBI3C, Strand B: Cellular Biology

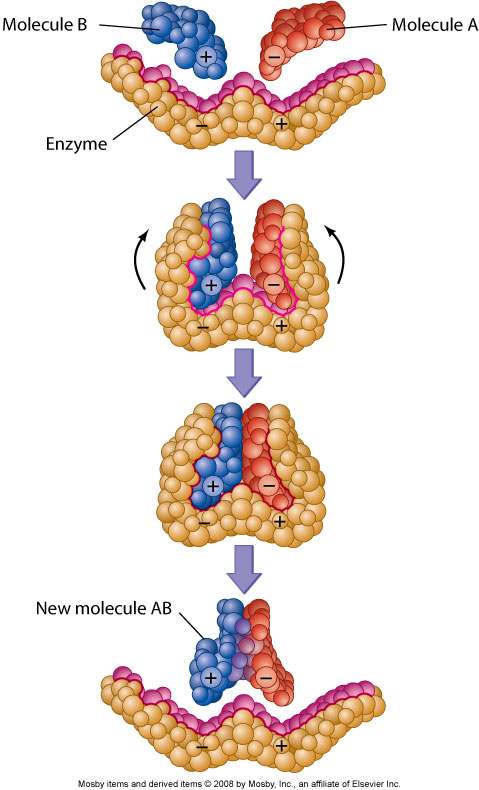
B2.4 investigate the effects of various qualitative factors on the action of enzymes (e.g., the effect of temperature or pH on the breakdown of starch by salivary enzymes)

B3.1 describe the structures and functions of important biochemical compounds, including carbohydrates, proteins, enzymes and lipids

Background Information:

Enzymatic activity in our biological system is crucial since they catalyze the chemical reactions required for metabolism. Thus, enzymes convert reactant to product but are not reactants or products themselves, furthermore, enzymes are regenerated after a reaction. Enzymes help to speed up reactions by decreasing the activation energy barrier. The shape of the enzyme is essential to the protein’s function. Each enzyme has a shape that fits a specific molecule much like a lock and key. In fact, the lock and key model depicted below shows how enzymes are functional proteins and their molecular shape allows them to catalyze reactions. For example as seen in figure 1, molecules A and B are inactive separately however, when brought together by the enzyme a large active AB molecule is produced.

Figure 1: Lock and Key Model (G.A. Thibodeau and K.T. Patton)



Molecules A and B are known as substrates. Each enzyme has a specific substrate. The area on the enzyme where the substrate bonds is called the active site.

There are three major types of enzymes in the human body. Metabolic enzymes are necessary for energy production. Digestive enzymes are required for the breakdown of food into nutrients. Salivary amylase is such an enzyme, it is found in the mouth where it breaks down starch. The nutrients enter the bloodstream where they are delivered to tissues. Both metabolic and digestive enzymes are produced within the body. However, food enzymes are obtained in the food that we eat. For example, our body does not naturally make cellulase, which is needed to process cellulose.

Normal body temperature is approximately 37⁰C, this is the optimal temperature for enzyme activity. Temperatures above this will cause the enzyme to denature and activity to be lost. Similarly, each enzyme operates efficiently at an optimal pH level. Enzymes that reside in the stomach will function around a pH = 3, in contrast, enzymes that reside in the blood will function at pH = 7-8.

Advanced Preparation/Special Materials:

*Lesson 1: Enzyme Demonstration Using Apples*

The teacher should have enough apples for each person in the class. Before giving the apples to the students, the teacher should ensure that no students have allergies. A bottle of lemon juice is also required. The work sheet (found below will be given out after the demonstration)

Work Sheet Questions:

1. What is the purpose of enzymes?

2. What are examples of things that they allow cells to do?

3. What are enzymes made of?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ About how many?\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. What does the enzyme maltase do?

5. What does the enzyme lactase do?

6. How does the enzyme amylase work?

7. What is a catalyst?

8. Why must enzymes have the correct shape?

9. What conditions can change their shape?

10. What is a “substrate”

*Lesson 2-3: What is an enzyme? What is metabolism?*

Students will be watching a video, therefore, a TV or projector will be needed. As well, textbook, journals, computer, internet will be required for jigsaw activity.

*Lesson 4: Students Create Mind Maps on Enzyme Function in Metabolism / Laboratory Exercise*

Students will need safety goggles for experiment. As well, students will be using acid and bases. Teacher will need to go over use of chemicals and proper disposal techniques. The teacher will have to set up the stations in advance. Station 1 will require fruits, station 2 will need a hot plate and beaker; station 3 will need a pH probe, acid and base solutions. The concentration of the acid and base solutions will have to be prepared in advance.

Student Difficulties:

Students may experience difficulties understanding the body contains thousands of enzymes, each with a specific substrate and a specific function. As well, some enzymes are involved in joining two molecules to produce an active molecule, while other enzymes are involved in breaking apart molecules so that it can be taken up by the bloodstream and tissues. Students may also have difficulty grasping the idea that an enzyme is a protein. Protein is usually seen as an essential dietary requirement that gives the body energy.

Evaluation Procedures:

*Lesson 1: Enzyme Demonstration Using Apples*

In small groups students will fill out the worksheet. Teacher will discuss with each group their understanding of enzymes. At the end of the lesson, the teacher will have a class discussion taking up the answers on the worksheet.

*Lesson 2-3: What is an enzyme? What is metabolism?*

Before the jigsaw strategy is performed the teacher will meet with each expert group and discuss / assess their findings on their topic. The teacher will clarify any misconceptions the students may have.

*Lesson 4: Students Create Mind Maps on Enzyme Function in Metabolism / Laboratory Exercise*

Mind maps will be collected and formally marked for completeness and accuracy. Students will be assessed in the laboratory based on experimental conduct. Peer evaluations will be used to ensure students are on task. At each station a specific question will be proposed, for example, what affect does temperature have on enzyme activity? Students will be assessed at the end of the experiment based on a class discussion with the teacher. The questions for the three stations will be used to lead the discussion. (Station 1: What fruits contain enzymes that digest protein? Station 2: What affect does temperature have on enzyme activity? Station 3: What affect does pH have on enzyme activity?)

Applications and Societal Issues/Implications:

Enzymes are known for their activity in digestion. Many health food stores sell papaya enzymes as an aid in digestion for dietary carbohydrate, protein and fat. In fact, the papaya enzymes are thought to help with constipation if taken after each meal. Papaya contains the papain enzyme, which decreases gas and bloating.

Cellulase is an enzyme required to breakdown cellulose, the structure found in fibre. However, our body does not make cellulase. Without this enzyme it is difficult for our body to digest fibre which also leads to constipation. Constipation is now becoming popular in society for a number of reasons, for example, lack of water, fibre and vegetable intake. Cellulase can be obtained from vegetables, supplements are also available.

Furthermore many health conditions are a cause of malfunctioning enzymes, for example lactase is an enzyme necessary for lactose digestion, a protein found in diary products. Many individuals become lactose intolerant in their early adulthood due to the lack of production of lactase in their body. The result is severe stomach pain when lactose is ingested. Lactase supplements can now be purchased to help in digestion when diary products are eaten. The medicine must be taken 30 minutes before eating diary products.

Lesson Sequence:

Diagnostic and Demonstration

What is Enzyme? What is Metabolism

Mind Maps and Labs on Enzymes

Lab: <http://www.accessexcellence.org/AE/AEPC/WWC/1991/enzymes.php>

Annotated References:

Alberts, B., et al. Essential Cell Biology: An Introduction to the Molecular Biology of the Cell. (1998). New York, New York: Garland Publishing Inc.

The book describes the cellular function of eukaryotic cells. Enzymes are discussed throughout the book. The book categories the function of enzymes based on the location in the body.

Alberts, B., et al. Molecular Biology of the cell, 4th Ed. (2002). New York, New York: Garland Science.

This book was written by the same authors as above. The book also discusses the different types of enzymes based on structure and function. The book discusses the transition state of enzymes and how they are successful in lowering activation energies.

Garrett, R.H. and Grisham, C.M. Biochemistry, 2nd Ed. (1999). United States of America: Saunders College Publishing.

This book is very advanced. It discusses enzymes at the molecular level, thus how enzymes fold to become active. As well, this book goes into detail regarding how the multiple polypeptide chain segments bond in order to form an active enzyme. Although this book is advanced it is useful to understand how the active site in an enzyme functions.

Patton, K.T. and Thibodeau, G.A. Structure and Function of the Body, 13th Ed. (2008). United States of America: Mosby Elsevier.

This book is easy to read and it has great pictures that can be used when making a power point presentation. The book goes into detail regarding the lock and key model. The book defines a substrate and how it is specific to an enzyme.

Annotated Internet Addresses:

MedicieNet.Inc (2011). Lactase Deficiency. Retrieved on July 18, 2011. http://www.medicinenet.com/lactose\_intolerance/article.htm

This on-line magazine discusses common disease conditions. The symptoms, preventions and treatments are covered. As well, the magazine attempts to explain why certain diseases occur.